Matching Uses and Protections for Government Data Releases

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In this talk we describe work-in-progress that aims to align emerging methods of data protections with research uses. We use the American Community Survey as an exemplar case for examining the range of ways that government data is used for research. We identify the range of research uses by combining evidence of use from multiple sources including research articles; national and local media coverage; social media; and research proposals. We then employ human and computer-assisted coding methods to characterize the range of data analysis methodologies that researchers employ. Then, building on previous work cataloging that surveys and characterizes computational and technical controls for privacy, we match these methods to available and emerging privacy and data security controls. Our preliminary analysis suggests that tiered-access to government data will be necessary to support current and new research in the social and health sciences.
Attribution Statement

Co-Conspirators:
- Cavan Capps, U.S. Census
- Zachary Lizee, U. Mass Boston
- Dylan Sam, Brown U.

Project Collaborators:
- Urs Gasser, David O’Brien, Ron Prevost, Salil Vadhan, and the Harvard University Privacy Tools Project

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Disclaimer

These opinions are my own, they are not the opinions of my employers, collaborators, or project funders.

Secondary disclaimer:

“It's tough to make predictions, especially about the future!”

- Attributed to Woody Allen, Yogi Berra, Niels Bohr, Vint Cerf, Winston Churchill, Confucius, Disraeli [sic], Freeman Dyson, Cecil B. Demille, Albert Einstein, Enrico Fermi, Edgar R. Fiedler, Bob Fourer, Sam Goldwyn, Allan Lamport, Groucho Marx, Dan Quayle, George Bernard Shaw, Casey Stengel, Will Rogers, M. Taub, Mark Twain, Kerr L. White, etc.
Related Work


Broader Context
Of
Use and Risk
for Government Information
Functions of Government Information

- Official decision & communications
- Broader social benefit (research and business uses)
- Public transparency and accountability
Harm Depends on Privacy & Sensitivity

Illustrating how to choose privacy controls that are consistent with the uses, threats, and vulnerabilities at each lifecycle stage.
Changes in Data Collection, Environment Change Identifiability, Threats and Vulnerabilities

A shift from one-time to high-frequency data collection.
## Example temporal risk factors for big data

<table>
<thead>
<tr>
<th></th>
<th>Identifiability</th>
<th>Threats (sensitivity)</th>
<th>Vulnerabilities (sensitivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>Small decrease</td>
<td>Moderate increase</td>
<td>Moderate decrease</td>
</tr>
<tr>
<td><strong>Period</strong></td>
<td>Small increase</td>
<td>Moderate increase</td>
<td>No substantial evidence of effect</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>Large increase</td>
<td>Small increase</td>
<td>No substantial evidence of effect</td>
</tr>
</tbody>
</table>
Approaches to Managing Informational Harm
### Informational controls

- Procedural, technical, educational, economic, and legal means for enhancing privacy can be applied at different stages

<table>
<thead>
<tr>
<th>Access/Release</th>
<th>Procedural</th>
<th>Economic</th>
<th>Educational</th>
<th>Legal</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Access controls; Consent; Expert panels; Individual privacy settings; Presumption of openness vs. privacy; Purpose specification; Registration; Restrictions on use by data controller; Risk assessments</td>
<td>Access/Use fees (for data controller or subjects); Property rights assignment</td>
<td>Data asset registers; Notice; Transparency</td>
<td>Integrity and accuracy requirements; Data use agreements (contract with data recipient)/ Terms of service</td>
<td>Authentication; Computable policy; Differential privacy; Encryption (incl. Functional; Homomorphic); Secure multiparty computation</td>
</tr>
</tbody>
</table>
Sequencing controls

- Review of uses, threats, and vulnerabilities as information is used over time
- Select appropriate controls at each stage
What do technical controls control?

- **Controls on computation** --
  limit the direct computations that can be meaningfully performed
  - Common: file-level encryption, interactive-analysis systems (model servers)
  - Emerging: functional encryption, homomorphic encryption, secure public ledgers, personal data stores

- **Controls on inference**
  limit how learning from computations about the observed units
  - Common: redaction, SDL
  - Emerging: differentially private mechanisms

- **Controls on purpose**
  limit the domain of human activity to which inferences are applied.
  - Common: legal mechanisms
  - Emerging: executable policy languages; machine actionable taxonomies, personal data stores
Examples of appropriate privacy and security controls based on the risk drivers and intended mode of analysis identified a big data use case.

<table>
<thead>
<tr>
<th>Intended Mode of Analysis</th>
<th>Lower Risk</th>
<th>Big Data Risk Drivers</th>
<th>Higher Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population-level Statistical Analysis</td>
<td>Age, Period, Sample Size, Population Diversity</td>
<td>High Dimensional</td>
<td>High Dimensional &amp; High Frequency</td>
</tr>
<tr>
<td>Individual Analytics</td>
<td>Notice, Consent, Terms of Service; Formal Oversight</td>
<td>High Frequency</td>
<td></td>
</tr>
</tbody>
</table>

- **Population-level Statistical Analysis**
  - Notice, Consent, Terms of Service; Formal Oversight

- **Individual Analytics**
  - Differential Privacy; Formal Oversight
  - Personal Data Stores; Blockchain Audit Logs; Secure Multiparty Computation; Formal Oversight
  - Secure Data Enclave/Model Server; Restricted Access; Formal Oversight
Characterizing Traces of Use

Access Logs

Published Analyses

Media and Social Media Mentions
Matching Uses and Protections

(Exploratory, Preliminary)
Identifying Current Modes of Dissemination

**Published Estimates**
- Official Indicators
- Pre-computed published tables

**Quick Lookups**
- Interactive queries to find a single number or table
- Based on pre-computed tables

**Dynamic Tables & Maps**
- Public interactive servers
- Based on public use tabulations or micro-data

**Public Use Tabulations**
- Aggregated to pre-defined geographical or logical units
- Processed statistical disclosure limitation methods
- Based on protected micro-data

**Public Use Micro-data**
- Processed with SDL: deidentification, sampling, synthetic data
- In rare cases, synthetic data used
- Based on protected micro-data

**Protected Micro-data**
- Possibly identified
- Available within Research Data Centers
What could this inform?

● Data prep
  ○ External data sources used
  ○ Cleaning - level
  ○ Linking - level

● Statistical computing approach
  ○ Sum queries/univariate method
  ○ Linear models/GLM
  ○ Likelihood
  ○ Bayesian estimates

● Diagnostics
  ○ Summary diagnostics
  ○ Sensitivity analysis
  ○ Individual outliers

● Desired purpose
  ○ Research
  ○ Policy
  ○ Commercial
  ○ Education

● Replication
  ○ Results
  ○ Full

● Data Characteristics
  ○ What ACS measures used
  ○ ACS Unit of analysis
  ○ Study unity of analysis
  ○ Time dimensions
  ○ Other Structure
    ■ Network
    ■ Textual
    ■ Spatial
    ■ Video

● Presentation characteristics
  ○ Summary/regression
  ○ Individual cases/plots
Conclusions

and/or

Provocations
Summary

● One size does not fit all
  -- anticipate that tiered access will be necessary to address major uses
● Government data supports several objectives
  -- government decision & communication; broader social benefit (research and economy); transparency and accountability
● Informational controls vary in compatibility --
  controls should be matched to objectives and modes of analysis
Provocations & Vigorous Hand Waving

- *Discovery research (currently) requires access beyond limits of formal protections* -- empirically guided exploratory research, theory generation, process tracing, novel syntheses (etc.) are incompletely understood and formalized

- *A representative use isn’t* -- need to consider multiple uses and tensions between these to get substantial social benefit avoid substantial harms

- *Worst-case analyses aren’t* -- some formal (DP) and legal analysis (Title 13) take worst case approach to inferential risk, but...
  -- apply average-case analysis to use/utility reduction
  -- are optimistic about operational/implementation risks
Non-temporal risk factors of big data also affect privacy risk components in different ways.

High-dimensional data pose challenges for traditional privacy approaches such as de-identification, and can support new uses of data that were unforeseen at the time of collection.

Broader analytic uses, such as the use of data for personalized classification, and both traditional and modern approaches to de-identification fail to protect against learning facts about populations that could be used to discriminate.

Increases in sample size and diversity lead to heightened risks that a target individual is included, vulnerable populations are included, and a wide range of threats are plausible.
Questions? Observations? Arguments?*

Now
(10 minutes)

or

Later
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*£1 for a five minute argument, but only £8 for a course of ten.